CLAIMS

We Claim:

1. A catalyst system comprising a cyclic germanium bridged bulky ligand metallocene-type catalyst compound and an activator.

2. The catalyst system of claim 1 wherein the cyclic germanium bridged bulky ligand metallocene-type catalyst compound has two bulky ligands.

3. The catalyst system of claim 2 wherein the bulky ligands are differently substituted.

4. The catalyst system of claim 1 wherein the cyclic germanium bridged bulky ligand metallocene-type catalyst compound is represented by the formula:

$$L^A(R'GeR')_xL^BMQ_n \qquad (I)$$

where M is a Group 3 to 7 transition metal, L^A and L^B is an unsubstituted or substituted, cyclopentadienyl ligand or cyclopentadienyl-type bulky ligand bonded to M; $(R'GeR')_x$ is a cyclic bridging group bridging L^A and L^B, and the two R''s form a cyclic ring or ring system with Ge; independently, each Q is a monoanionic ligand, or optionally two Q's together form a divalent anionic chelating ligand; and where n is 0, 1 or 2 depending on the formal oxidation state of M, and x is an integer from 1 to 4.

5. The catalyst system of claim 4 wherein one of L^A or L^B is a substituted cyclopentadienyl or a substituted cyclopentadienyl-type bulky ligand.

6. The catalyst system of claim 1 wherein the catalyst system is supported.

7. The catalyst system of claim 4 wherein x is 1.

8. The catalyst system of claim 1 wherein the cyclic germanium bridged bulky ligand metallocene-type catalyst compound is represented by the formula:

$$L^A(R'GeR')_xL^BMQ_n \qquad (I)$$

where M is a Group 4, 5, 6 transition metal, L^A and L^B are bonded to M and are different, L^A and L^B are selected from the group consisting of unsubstituted or substituted, cyclopentadienyl ligands or unsubstituted or substituted, cyclopentadienyl-type bulky ligand; $(R'GeR')_x$ is a cyclic bridging group bridging L^A and L^B, and the two R''s form a cyclic ring or ring system with Ge; independently, each Q is a monoanionic ligand, or optionally two Q's together form a divalent anionic chelating ligand; and where n is 0, 1 or 2 depending on the formal oxidation state of M, and x is an integer from 1 to 4.

9. The catalyst system of claim 8 where x is 1.

10. The catalyst system of claim 8 wherein L^A and L^B are substituted or unsubstituted cyclopentadienyl rings.

11. The catalyst system of claim 8 wherein a least one of L^A and L^B is a cyclopentadienyl ring.

12. The catalyst system of claim 8 wherein L^A is a substituted cyclopentadienyl ring.

13. The catalyst system of claim 1 where the cyclic germanium bridged bulky ligand metallocene-type catalyst compound is selected from one of the group consisting of cyclotrimethylenegermyl(tetramethyl cyclopentadienyl) (cyclopentadienyl) zirconium dichloride, cyclotetramethylenegermyl (tetramethyl cyclopentadienyl) (cyclopentadienyl) zirconium dichloride, cyclotrimethylenegermyl(tetramethyl cyclopentadienyl) (2-methyl indenyl) zirconium dichloride, cyclotrimethylenegermyl(tetramethyl cyclopentadienyl) (3- methyl cyclopentadienyl) zirconium dichloride, cyclotrimethylenegermyl (tetramethyl cyclopentadienyl) (2,3,5-trimethyl cyclopentadienyl) zirconium dichloride, cyclotrimethylenegermyl bis(tetra methyl cyclopentadienyl) zirconium dichloride, cyclotetramethylenegermyl(tetramethyl cyclopentadienyl) (3-methyl cyclopentadienyl) zirconium dichloride, cyclotetramethylenegermyl bis(tetra methyl cyclopentadienyl) zirconium dichloride, 3,4-dimethylcyclotetra-methyl-3-enegermyl(tetramethyl

cyclopentadienyl) (cyclopentadienyl) zirconium dichloride, 3,4-dimethylcyclotetramethyl-3-enegermylbis(tetramethyl cyclopentadienyl) zirconium dichloride, 3,4-dimethylcyclotetramethyl-3-enegermyl(tetramethyl cyclopentadienyl) (2,3,5-trimethyl cyclopentadienyl) zirconium dichloride, 3-methylcyclotetramethyl-3-enegermyl bis(tetra methyl cyclopentadienyl) zirconium dichloride, 3-methylcyclotetramethyl-3-enegermyl (tetra methyl cyclopentadienyl) (cyclopentadienyl) zirconium dichloride, 3-methylcyclotetramethyl-3-enegermyl (tetra methyl cyclopentadienyl) (3-methylcyclopentadienyl) zirconium dichloride, o-xylidenegermyl bis(tetra methyl cyclopentadienyl) zirconium dichloride, o-xylidenegermyl(tetramethyl cyclopentadienyl) (cyclopentadienyl) zirconium dichloride, and o-xylidenegermyl(tetramethyl cyclopentadienyl) (3-methylcyclopentadienyl) zirconium dichloride.

14. A process for polymerizing ethylene alone or in combination with one or more olefin(s) to produce a polymer product in the presence of a catalyst system comprising a cyclic germanium bridged bulky ligand metallocene-type catalyst compound and an activator.

15. The process of claim 14 wherein the cyclic germanium bridged bulky ligand metallocene-type catalyst compound has two bulky ligands.

16. The process of claim 14 wherein the bulky ligands are differently substituted.

17 The process of claim 14 wherein the polymer product is an ethylene copolymer having a I_{21}/I_2 greater than 35 and a melt strength greater than 7cN.

18 The process of claim 14 wherein the cyclic germanium bridged bulky ligand metallocene-type catalyst compound is represented by the formula:

$$L^A(R'GeR')_xL^BMQ_n \qquad (I)$$

where M is a Group 3 to 12 transition metal, L^A and L^B is an unsubstituted or substituted, cyclopentadienyl ligand or cyclopentadienyl-type bulky ligand bonded to M; $(R'GeR')_x$ is a cyclic bridging group bridging L^A and L^B, and the two R''s form a

cyclic ring or ring system with Ge; independently, each Q is a monoanionic ligand, or optionally two Q's together form a divalent anionic chelating ligand; and where n is 0, 1 or 2 depending on the formal oxidation state of M, and x is an integer from 1 to 4.

19. A process for polymerizing ethylene alone or in combination with one or more other olefin(s) in the presence of a catalyst system comprising a cyclic germanium bridged bulky ligand metallocene-type catalyst compound and an activator, the process producing a polymer product having a melt strength greater than 7 cN and an I_{21}/I_2 of greater than 35.

20. The process of claim 19 wherein the catalyst system further comprises a carrier.

21. The process of claim 19 wherein the polymer product has a M_z/M_w greater than 3, and an I_{21}/I_2 of greater than 65.

22. A continuous gas phase process for polymerizing ethylene and at least one alpha-olefin having from 3 to 20 carbon atoms in the presence of a catalyst system comprising a cyclic germanium bridged bulky ligand metallocene-type catalyst compound, an activator and a carrier, the process producing a polymer product having a density greater than 0.900 g/cc, I_{21}/I_2 greater than 35, and a melt strength of greater than 6 cN.

23. The process of claim 22 wherein the I_{21}/I_2 is greater than 50.

24. The process of claim 22 wherein the cyclic germanium bridged bulky ligand metallocene catalyst compound is represented by the formula:

$$L^A(R'GeR')_xL^BMQ_n \qquad (I)$$

where M is a Group 3 to 7 transition metal, L^A and L^B are bonded to M and are different, L^A and L^B are selected from the group consisting of unsubstituted or substituted, cyclopentadienyl ligands or unsubstituted or substituted, cyclopentadienyl-type bulky ligand; $(R'GeR')_x$ is a cyclic bridging group bridging L^A and L^B, and the two R''s form a cyclic ring or ring system with Ge; independently, each Q is a monoanionic ligand, or optionally two Q's together form a divalent anionic chelating

ligand; and where n is 0, 1 or 2 depending on the formal oxidation state of M, and x is an integer from 1 to 4.

25. The process of claim 14 wherein the activator is alumoxane.

26. The process of claim 14 wherein the process is a gas phase polymerization process.

27. The process of claim 18 wherein M is a group 4, 5 or 6 metal.

28. A continuous gas phase process for the polymerization of olefin(s) to produce a polymer product in the presence of a catalyst system comprising a cyclic germanium bridged bulky ligand metallocene-type catalyst compound and activator.

29. The process in accordance with claim 34 wherein the activator is alumoxane.

30. The gas phase process in accordance with claim 34 wherein the olefin(s) comprises ethylene alone or in combination with one or more other olefin(s).

31. A process for polymerizing olefin(s) to produce a polymer product in the presence of a catalyst system comprising a saturatewd or monounsaturated cyclic germanium bridged bulky ligand metallocene-type catalyst compound and an activator.

32. The process in accordance with claim 37 wherein the activator is alumoxane.

33. The process of claim 38 wherein the cyclic germanium bridged bulky ligand metallocene-type catalyst compound is represented by the formula:

$$L^A(R'GeR')_xL^BMQ_n \qquad (I)$$

where M is a Group 3 to 12 transition metal, L^A and L^B is an unsubstituted or substituted, cyclopentadienyl ligand or cyclopentadienyl-type bulky ligand bonded to M; $(R'GeR')_x$ is a cyclic bridging group bridging L^A and L^B, and the twoR''s form a saturated or monounsaturated ring or ring system with Ge; independently, each Q is a monoanionic ligand, or optionally two Q's together form a divalent anionic chelating ligand; and where n is 0, 1 or 2 depending on the formal oxidation statew of M, and x is an integer from 1 to 4.

34. An ethylene copolymer having a melt strength greater than 7cN and a I_{21}/I_2 greater than 35.

35. The ethylene copolymer of claim 25 wherein the I_{21}/I_2 is greater than 40.

36. The ethylene copolymer of claim 25 wherein the I_{21}/I_2 is greater than 60.

37. The ethylene copolymer of claim 25 wherein the I_2 is about 0.5 to 2 dg/min.

38. The ethylene copolymer of claim 25 wherein the ethylene copolymer has a density greater than 0.910 g/cc.

39. The ethylene copolymer of claim 25 wherein the ethylene copolymer is an ethylene/hexene-1 copolymer.